Expendable Bioluminescence Detectors (XBPM) Status Report

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LONG-TERM GOALS / OBJECTIVES

The technical objectives associated with this phase of the XBPM project are focused on implementing the Phase I analysis and testing to the point of producing a small quantity of reusable and expendable free falling bioluminescence detectors, RBPM and XBPM respectively. One of the first milestones during this phase is the completion of 10 to 15 reusable bioluminescence detectors for use by NAVO and Universities that have expressed interest in using the devices. These will be used as a reliable and reusable model to gather additional data and refine the concept for the expendable model.

Additional objectives in this Phase of the program involve reviewing the Phase I analysis and expanding on the research and development necessary to produce an expendable model of the BPM. The RBPM units, and the work involved with building those units, will be used as a basis for the design and production of the XBPM unit. The XBPM will be optimized as a low-cost and easy to produce unit focused on the potential high production quantity for the US Navy fleet.

WORK COMPLETED / RESULTS

The approach to the development of the XBPM (Expendable Bathy-Photometer) is to use knowledge gained from the engineering effort for the RBPM (Re-usable Bathy-Photometer) to construct an economical expendable unit. Since the RBPM is re-usable, premium components can be used such as a large surface area - low noise photodiode, titanium diaphragm pressure transducer, welded aluminum housing, dual power supply, a precision turned optical window, and a high resolution digitizer. The objective was to make the RBPM provide the best performance for the geometry and method used, while creating a platform for investigators to use for both data collection and performance evaluation.

The XBPM can provide similar performance in an expendable unit. To reduce the manufacturing cost, the detector, digitizer, power supply, processor, and the method for determining depth are being examined. A preliminary design has been done and a board set is being made for evaluation. Features on the RBPM such as the audible indicator, onboard data storage, and an external power supply option have been eliminated. The electronics necessary for driving the communications link is capable of handling both dual conductor bi-filar wire (baseband) and single wire (FSK). Generation of the signals

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is handled in software and the reconfiguration of a few passive components will allow either method to be used. This version uses the removal of a magnet to assert power. The final version however may use the removal of a metal clip from two pins (the same clip that is used to release the XBPM). The exposed pins will then serve as a water contact sensor or sea water return for single wire communications.

An additional cost reducing approach is simplifying the complexity of the board and the mechanical assembly. The use of a ported pressure sensor requires that exposure to the water be made. While the use of a waxy interface between the sea water and the pressure sensor diaphragm may work well in a one time use device, the process to manufacture and hold repeatable tolerances from unit to unit may cause problems. To solve this, the use of a MEMS (Micro Electro Mechanical Systems) accelerometer is being evaluated. These sensors have seen considerable use as air bag deployment detectors, but are finding use in a variety of consumer products. For example, disk drives in notebook computers now use a MEMS accelerometer to detect if they have been knocked off a desk. The sudden drop causes the head to park before damage can occur from hitting the floor. Popular home entertainment games use a MEMS accelerometer to measure operator movement.

To evaluate this, a modified RBPM is being constructed that records a single axis acceleration (drop to the water), de-acceleration (hitting the water), and then final acceleration (XBPM reaching a nominal terminal velocity of 2 meters per second). Drop tests will be performed from the WHOI dock that will demonstrate if this is a viable alternative. It may turn out that acceleration in conjunction with a water contact switch will provide depth determination that will rival the direct pressure method.

A calibrator for the RBPM/XBPM has been completed that provides very accurate and repeatable low flux optical levels. This device is essential for the evaluation of the detector and digitizer pairing at equivalent weak BL signal levels. The original WHOI design used a 12 bit analog to digital converter paired with a low noise photodiode. The resulting sensitivity was considered to be adequate for NAVO purposes. The approach is to use lower cost blue enhanced detectors, converters in the 12 to 14 bit range, and an optimum reference voltage to extract the best signal for the cost. Comparisons will be made over 4 decades of light level. A fixture is being made to adapt different bit width converters and detectors to the calibrator. A first order test will not use corrective optics.

Additionally, mechanical items such as the housing material have been reviewed. Keeping in mind the goals of low cost, high volume and expendability, a biodegradable housing material has been identified and will be tested further. The material cost is relatively low and can withstand the drop necessary for the units. Specifications on tensile is 24Mpa = approximately 3400 PSI. Elongation at break = 560 %.

CONCLUSION / FUTURE WORK

Teledyne Benthos, Inc. and the Woods Hole Oceanographic Institute have completed a large amount of research, development and prototype manufacturing on the reusable and expendable free falling bioluminescent detectors. Prototype RBPM units have been shipped to NAVO and NRL for their review and use. We look forward to their feedback as we continue on our development path of the XBPM units. Additionally a calibration system has been designed and will be refined as necessary for high quantity production. The current unit will be utilized for the RBPM units.

Future work will focus on the research mentioned above and other aspects of the design that will allow us to migrate from the RBPM to the XBPM. These items include the launcher and deck unit hardware, XBPM software, wire communication design, assembly and test fixtures, documentation and suggested high production lean cell manufacturing layouts.